

National Marine Fisheries Service Habitat Conservation Efforts in the Southeast Region of the United States From 1981 Through 1985

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Introduction

Each year thousands of requests are made to the U.S. Army Corps of Engineers (COE) for permission to alter wetlands. The National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA) provides recommendations to the COE that are designed to minimize project effects on marine, estuarine, and anadromous fishery resources. Because the amount, type, and geographical distribution of the habitat to be altered are generally unknown, the NMFS Southeast Region began a program in 1980 to compile such information. Another important purpose of the program is to determine the effectiveness of NMFS recommendations. This information not only helps us determine cumulative loss of habitat so the necessary measures can be taken to prevent

avoidable damages to fisheries production, but it also allows us to judge the effectiveness of our program so necessary modifications can be made.

Lindall and Thayer (1982) described efforts by the NMFS to quantify the NMFS Southeast Region's involvement in COE programs during the 1981 fiscal year (October 1980-September 1981). They showed that 1,400 permits involving almost 18,000 acres of wetlands were involved. We now have data that quantify efforts for 5 years (1981-85). These data reflect the magnitude of the potential wetland alterations, the acreage actually permitted for alteration, and the acreage potentially mitigated.

Since mitigation is becoming a major part of NMFS efforts to conserve fisheries habitat, NMFS Southeast Fisheries Center (SEFC) efforts in evaluating the effectiveness of mitigation recommendations are described. Mitigation seeks

to reduce or eliminate adverse impacts, and NMFS only recommends mitigation to compensate for unavoidable loss of resources due to human activities when all realistic alternatives to avoid impacts have been evaluated (Thayer et al., In press; Ashe, 1982). Unfortunately the process of mitigation is generally untested, and we do not know if mitigated habitats support the production of fishery organisms to the extent that unaltered natural systems do. This information is vital in view of the increasing use of mitigation to compensate for habitat loss and is invaluable to the evaluation of project effects.

The information we provide covers only the wetlands in the NMFS Southeast Region (North Carolina to Florida to Texas plus Puerto Rico and the U.S. Virgin Islands) upon which marine, estuarine, and anadromous fishery resources managed by the NMFS depend. Other wetland conservation programs exist for which we have no data. For example, each state in the Southeast Region has wetland conservation programs for resources under its purview. The same holds for other programs such as those pursued by the U.S. Fish and Wildlife Service (FWS) and the Environmental Protection Agency (EPA).

Background

The NMFS Southeast Regional Office and the SEFC are responsible for the

ABSTRACT—The National Marine Fisheries Service (NMFS) is quantifying the cumulative acreage of habitat involved in the Corps of Engineers' (COE) programs relating to water development in the Southeast Region of the United States. From January 1981 through December 1985 the NMFS commented on 23,292 proposals to alter wetlands that had been submitted to the COE. Of these, detailed habitat information was obtained on 5,385 projects involving the potential alteration of 184,187 acres of wetlands. Dredging was proposed for over 80,227 acres and 45,893, 5,846, and 52,222 acres were proposed for filling, draining, and impounding, respectively. NMFS did not object to the alteration of 48,500 acres and recommended the conservation of 135,687

acres. The proposed habitat losses were potentially offset by the 110,406 acres recommended for mitigation. The degree to which our recommendations were incorporated into permits by the COE also was documented. NMFS recommendations were accepted over all 50 percent of the time, partially accepted 24 percent of the time, and rejected 26 percent of the time. Applicant compliance with permit conditions averaged 80 percent. NMFS recommendations on permit applications are made by the Southeast Regional Office and its area offices, but are dependent on up-to-date research information provided by research laboratories of the Southeast Fisheries Center. The close link between these facilities in NMFS fisheries habitat conservation efforts is described.

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protection, management, and development of marine fisheries from North Carolina to Florida to Texas, including Puerto Rico and the U.S. Virgin Islands. In the Southeast Region at least 96 percent of commercial fishery landings and over 70 percent of the amount of recreational fish caught consist of species that inhabit estuaries at some point in their life cycle.

The commercial yield of these species (including Alaska, but excluding Puerto Rico and the U.S. Virgin Islands) for 1981 through 1985 was about 46 percent of the total U.S. landings (NMFS, 1983; 1985; 1986). This amounted to about 13.6 billion pounds of fish and shellfish worth at least \$3.8 billion at dockside in the Southeast Region. Marine recreational yield in the southeast for 1981 through 1985 was about 56 percent of the total recreational landings in the United States. This amounted to about 1 billion fish taken by recreational fishermen from North Carolina to Texas (NMFS, 1985; 1986).

This coastal area is experiencing rapid changes in land use patterns. These changes are associated with human population growth, and are leading to physical loss of vital fishery habitat, closure of fish and shellfish areas due to contamination, fish mortality due to hypoxia, and diseases that are linked to poor water quality. The most significant environmental alterations related to fishery losses are physical modification of habitat, addition of biological and chemical pollutants, and alteration of freshwater inflow patterns (Lindall et al., 1979; Tiner, 1984).

Effective management of fisheries for the nation's benefit relies largely on maintaining and enhancing critical habitat. The importance of estuarine habitat to commercial and recreational marine fisheries in the southeast is documented in Douglas and Stroud (1971), Thayer et al. (1975, 1979), Turner (1977), Peters et al. (1979) and Thayer and Ustach (1981). Alexander et al. (1986) estimated the remaining saltmarsh, fresh marsh, tidal flats, and swamp wetlands in the Southeast Region at only about 9.4 million acres, representing about 83 percent of the 11.3 million acres of remaining wetlands of these types in the

contiguous United States. Within these general wetland categories, some specific habitat types may be actually increasing in extent in some areas while others are disappearing at an unprecedented rate. Thus, it is important not only to obtain information on major wetland habitat types (e.g., Alexander et al., 1986), but also the acreage and distribution of specific wetland habitat types (e.g., Tiner, 1977; 1985).

Wetland losses occur continuously from natural causes, although currently there is no way to quantify them adequately. Erosion, subsidence, marsh deterioration, and rising sea levels are but a few of the natural forces that alter wetlands. In Louisiana, for example, natural and human-induced forces contribute to a yearly land loss, including marsh, of more than 32,000 acres or 50 square miles (Gagliano, 1984). In view of these continuing wetland losses, the need to closely monitor and minimize the effects of avoidable losses, such as those affected by state and federal regulatory wetlands programs, is even more vital. This is the primary reason NMFS monitors activities that potentially alter wetlands.

NMFS Southeast Region habitat conservation activities are carried out by 13 fishery biologists in the Habitat Conservation Division (HCD) located in four offices: Beaufort, NC; St. Petersburg, Fla.; Panama City, Fla.; and Galveston, Tex. Lindall and Thayer (1982) provide greater detail on operation of these offices. A fifth office is planned for Baton Rouge, La., in 1986. Each year these biologists review 4,700-6,000 permit applications. Added to this workload are other federal, state, and local projects, preapplication meetings, review of environmental planning documents, meetings to resolve conflicts with permit applications, and a host of related activities. Because of the tremendous workload and size of the area covered, the HCD relies on SEFC research expertise to obtain up-to-date information upon which to base its recommendations. This is necessary to ensure that recommendations are valid and defensible. The Fishery Habitat Program of the SEFC is located at the Beaufort and Galveston Laboratories. Research infor-

mation needs of the HCD are incorporated into ongoing research projects, which include larval fish ecology, use of wetland habitats by fishery organisms, development of habitat evaluation techniques, evaluation of mitigated habitats, and effects of contaminants (primarily heavy metals), and habitat losses on ecologically and economically important species.

The NMFS recognizes that conservation of nearshore and marine fishery habitats is fundamental to any attempt to rationally manage fisheries, and mitigation is considered if there are no alternatives to projects that are water dependent, needed for national defense, or high in public interest. Projects considered in the public interest by the COE continue to cause alteration and loss of wetland habitat, particularly when their cumulative impacts are considered (Thayer et al., *In press*). Mitigation recommendations are made to lessen the impact of development to fishery habitats. In making mitigation recommendations, NMFS attempts to reestablish wetland fishery habitats and their ecological functions. Although techniques do exist to revegetate salt marsh, mangroves, and seagrass meadows (see Thayer et al., *In press*), there is little evidence that these habitats are capable of supporting or sustaining the production of fishery organisms as do their natural counterparts. Accordingly, the SEFC Fishery Habitat Program at Beaufort and Galveston has initiated research efforts to evaluate the use of mitigated habitats by fishery organisms.

In a review of mitigation in the Southeast Region, Thayer et al. (*In press*) noted that mitigation can take several forms: Preapplication, habitat creation, restoration and enhancement, and mitigation banking. NMFS seeks alternative sites for projects, less-damaging construction methods, etc., in seeking to lessen or avoid impact in preapplication meetings and during review of public notices that advertise projects. One of the major wetland mitigation tools used by NMFS is recommending restoration or generation of habitat to replace wetlands that have been altered illegally or are proposed to be altered for activities such as water-dependent projects (Lin-

dall et al., 1979; Thayer et al., 1985; In press). This technique has been readily accepted as evidenced by the large amount of habitat recommended by NMFS and approved by the COE for restoration and generation. The NMFS in making mitigation recommendations, attempts to have in-kind mitigation or habitat replacement conducted adjacent to the area of habitat loss or in the same aquatic system. We continue to stress, however, that mitigation is still an experimental technique that has not been adequately evaluated.

A cooperative agreement between NOAA and the U.S. Department of the Army (Civil Works) was signed in October 1985 for a series of pilot studies to evaluate the feasibility of establishing a national program for restoring and creating fishery habitat. The agreement is intended to merge the NMFS interest in the nation's fisheries productivity and the COE's water resources development program, engineering expertise, and experience. The NMFS Southeast Region was selected as one of the pilot study areas. Currently, sites are being selected where wetlands can be created or enhanced to restore fisheries habitats which were degraded or destroyed in the past. The COE will be responsible for designing or modifying sites appropriate to the fishery habitat creation or enhancement needs, and NMFS will be responsible for evaluating the viability of these areas for fishery organisms.

A computerized system to track permit recommendations and proposed habitat alterations involved in COE programs in the southeast began in late 1980 and was preliminarily reported in Lindall and Thayer (1982). The system has been developed and five years of data are now available. NMFS tracks individual actions by the amount of potential impact (i.e., dredge, fill, drain, impound); the amount of habitat modification NMFS accepts or does not object to; the amount of habitat potentially conserved; and the amount of habitat modification actually permitted by the COE. The latter data track only those permits where we are notified of issuance by the COE and we have historical data to judge what habitat alterations were originally proposed.

Data can be retrieved by project location, habitat type, timeframe, impact, and whether restoration or generation of habitat was involved. Data also can be retrieved by the kind of activity involved (e.g., permit application, unauthorized activity, federal project); the type of project (e.g., navigation, oil and gas, housing development, beach restoration, mineral mining, barriers, and impoundments); and whether NMFS objected to, recommended modifications, or approved the activity. The results of the first 5 years of quantification of NMFS efforts are summarized in the next section.

The acreage values associated with permit actions reflect projected losses due to direct removal, burial, impounding, and draining. Frequently, particularly in the case of seagrass habitats, additional habitat loss can be incurred that the project-specific permitting process does not address. There are few areas in the Southeast Region where recent accurate maps of seagrass distribution have been completed. Where maps do exist, declines in seagrass species frequently have been reported (e.g., Tampa Bay, Fla.). The magnitude of the losses that have occurred or are projected to occur through the permitting process are highly conservative. This is due to the fact that seagrasses and other submerged aquatic plants are dependent on good water quality, specifically low water turbidity, to survive. Increased turbidity, which often is the result of nonpoint source pollution and related discharge problems, are not addressed by the permit process or in our data.

Results

From 1 January 1981 to 31 December 1985 the NMFS responded to 23,292 permit actions from the COE for review and comment. These actions included the following types and number of construction activities: Bulkheads, ramps, groins, and other shoreline activities (8,599); oil and gas exploration and development projects (4,938); navigation channels and marinas (2,943); unauthorized construction in wetlands (1,572); unclassified (1,553); pipelines (1,289); bridges and highways (632);

housing developments (475); industrial developments (374); barriers, dams, and impoundments (292); transmission lines (248); irrigation projects (193); mining activities (80); electric generating facilities (53); and beach restoration projects (51). Of these, 17,165 (74 percent) were given a "no objection" response because our analysis showed that adverse impacts would be minimal or damage could be restored or mitigated through appropriate construction techniques. In-depth analyses were conducted on 5,596 actions (24 percent) because it appeared that adverse effects to fishery resources could occur if the project were conducted. The remaining 531 proposals (2 percent) were not assessed because of insufficient staff and funds or because the public notice stated that the COE would only consider recommendations pertaining to navigation and national security. The latter cases involved COE permits for placing oil rigs in offshore waters.

NMFS habitat conservation efforts are summarized in Table 1 by state, the number of permit applications reviewed, and the acreage of habitat involved in dredging, filling, draining, and impounding. Summaries are given in Table 2 by year, and a listing by habitat type proposed for alteration, allowed or not objected to by NMFS, potentially conserved, and mitigated is provided in Table 3. Region-wide quantification of these data is briefly described below.

Dredging

During the 1981-85 period (Table 1, column 2), 80,227 acres were proposed for dredging. Of this total, 88 percent was in Louisiana, 4 percent in Texas, 3 percent in Florida, 1 percent in North Carolina, and 4 percent in the remaining states, Puerto Rico, and the U.S. Virgin Islands. The NMFS did not object to dredging 30,139 acres (Table 1, column 6), but recommended against dredging in 50,088 acres (Table 1, column 10). Most of the proposed dredging was for navigation, especially by the oil and gas industry in Louisiana to gain access to well sites.

Unvegetated substrates (Table 3) proposed to be dredged comprised 76,503 acres (95.4 percent) of the 80,227 acres

Table 1.—Number of proposed projects and acres of habitat by state involved in NMFS habitat conservation efforts from 1981 through 1985. Numbers in parentheses refer to columns discussed in text.

State	No. of permit applications (1)	Acreage proposed by applicants				Acreage NMFS accepted or did not object to				Potential acreage conserved				Mitigation recommended by NMFS	
		Dredge (2)	Fill (3)	Drain (4)	Impound (5)	Dredge (6)	Fill (7)	Drain (8)	Impound (9)	Dredge (10)	Fill (11)	Drain (12)	Impound (13)	Restore acreage (14)	Generate acreage (15)
LA	1,229	70,657.3	36,513.5	5,139.9	37,563.8	24,558.2	7,939.3	160.5	6,274.3	46,099.1	28,574.2	4,979.4	31,289.5	92,471.8	10,914.3
TX	684	3,541.9	3,916.3	0.1	9,186.0	2,017.8	688.9	0	987.4	1,524.1	3,227.4	0.1	8,198.6	3,904.8	557.2
MS	94	120.3	386.6	5.0	6.3	61.4	245.7	0	0	58.9	140.9	5.0	6.3	6.2	37.4
AL	206	423.5	533.9	0	1.9	226.6	53.0	0	0	196.9	480.9	0	1.9	40.1	7.1
FL	1,806	2,733.1	2,870.8	0.5	275.1	1,914.3	926.1	0.2	5.8	818.8	1,944.7	0.3	269.3	475.4	765.1
GA	194	625.6	411.5	0	69.2	94.4	109.9	0	0.2	531.2	301.6	0	69.0	34.1	213.0
SC	576	844.5	419.3	0	4,345.9	333.6	103.4	0	12.5	510.9	315.9	0	4,333.4	68.0	41.1
NC	547	1,133.6	612.0	700.0	673.9	869.0	435.1	300.0	68.4	264.6	176.9	400.0	605.5	491.4	85.0
PR	42	66.7	180.2	0	100.0	18.1	15.3	0	0	48.6	164.9	0	100.0	147.7	11.5
VI	7	80.4	48.7	0	0	45.4	35.5	0	0	35.0	13.2	0	0	0	134.5
Total	5,385	80,226.9	45,892.8	5,845.5	52,222.1	30,138.8	10,552.2	460.7	7,348.6	50,088.1	35,340.6	5,384.8	44,873.5	97,639.5	12,766.2

Table 2.—State and yearly totals for acres of habitat involved in NMFS habitat conservation efforts from 1981 through 1985.

State	1981	1982	1983	1984	1985	Total
<i>Acreage proposed for dredging, filling, draining and impounding</i>						
Louisiana	3,565.4	73,753.1	12,398.3	4,415.8	55,742.3	149,874.9
Texas	1,253.8	2,801.3	5,444.3	2,076.6	5,068.3	16,644.3
Mississippi	37.8	54.0	84.7	48.4	293.1	518.0
Alabama	80.2	419.3	85.5	322.6	51.8	959.4
Florida	1,159.8	1,082.9	1,056.7	840.3	1,739.7	5,879.4
Georgia	266.0	280.5	84.8	34.6	440.4	1,106.3
South Carolina	1,027.5	2,670.8	1,070.6	196.7	644.0	5,609.6
North Carolina	490.3	75.9	460.2	541.5	1,551.5	3,119.4
Puerto Rico	67.8	46.4	16.9	104.6	111.1	346.8
Virgin Islands			75.9	25.3	28.0	129.2
Total	7,948.6	81,184.2	20,777.9	8,606.4	65,670.2	184,187.3
<i>Acreage NMFS allowed or did not object to</i>						
Louisiana	1,897.1	20,818.2	7,352.4	3,015.3	5,849.0	38,932.0
Texas	96.4	351.5	484.1	258.8	2,503.5	3,694.3
Mississippi	26.8	3.9	10.2	15.9	250.2	307.0
Alabama	19.3	173.1	24.8	46.5	16.0	279.7
Florida	392.2	325.0	471.4	487.1	1,170.8	2,846.5
Georgia	26.9	32.9	78.8	25.8	40.0	204.4
South Carolina	35.9	72.5	113.8	50.4	176.9	449.5
North Carolina	369.1	43.5	55.8	77.8	1,126.4	1,672.6
Puerto Rico	4.5	10.5	13.9	3.6	0.9	33.4
Virgin Islands			53.0	0	27.9	80.9
Total	2,868.2	21,831.1	8,658.2	3,981.2	11,161.6	48,500.3
<i>Potential acreage conserved</i>						
Louisiana	1,668.2	52,934.8	5,045.7	1,400.4	49,893.2	110,942.3
Texas	1,157.5	2,449.8	4,960.2	1,817.8	2,564.8	12,950.1
Mississippi	11.1	50.1	74.5	32.5	42.9	211.1
Alabama	60.9	246.3	60.7	276.1	35.8	679.8
Florida	767.6	757.9	585.4	353.2	569.0	3,033.1
Georgia	239.1	247.6	6.0	8.7	400.4	901.8
South Carolina	991.6	2,598.3	956.8	146.3	467.1	5,160.1
North Carolina	121.3	32.4	404.4	463.7	425.1	1,446.9
Puerto Rico	63.3	36.0	3.0	101.0	110.2	313.5
Virgin Islands			22.9	25.3	0.1	48.3
Total	5,080.6	59,353.2	12,119.6	4,625.0	54,508.6	135,687.0
<i>Restore/generate acreage recommended or approved</i>						
Louisiana	1,212.6	7,513.2	26,027.9	53,083.6	15,548.8	103,386.1
Texas	1,032.8	117.0	127.1	99.0	3,086.1	4,462.0
Mississippi	17.5	2.8	1.8	2.2	19.3	43.6
Alabama	6.3	29.8	0.5	9.8	0.8	47.2
Florida	97.6	160.0	346.8	336.6	299.5	1,240.5
Georgia	5.5	57.0	119.7	16.0	48.9	247.1
South Carolina	19.7	21.4	9.1	22.4	36.5	109.1
North Carolina	43.0	6.8	14.4	480.3	31.9	576.4
Puerto Rico	36.1	1.9	12.7	0	108.5	159.2
Virgin Islands			115.0	0	19.5	134.5
Total	2,471.1	7,909.9	26,775.0	54,049.9	19,199.8	110,405.7
No. of permit applications	811	1,059	825	888	1,802	5,385

of habitat to be dredged, while vegetated wetlands totaled 3,724 acres (4.6 percent). NMFS did not object to dredging in 28,683 acres of unvegetated substrates (95.2 percent of the total for Table 1, column 6) and did not object to dredging in 1,456 acres of vegetated wetlands (4.8 percent). Vegetated wetlands potentially saved from dredging totaled 2,268 acres (4.5 percent of the total for Table 1, column 10) while unvegetated substrates totaled 47,820 (95.5 percent).

Filling

Filling of 45,893 acres (Table 1, column 3) was proposed: 79.6 percent in Louisiana; 8.5 percent in Texas; 6.2 percent in Florida; and 5.6 percent in the remaining states, Puerto Rico, and the U.S. Virgin Islands. The NMFS did not object to filling on 10,552 acres (Table 1, column 7): 75.2 percent of the filling which NMFS did not object to was in Louisiana; 8.8 percent in Florida; 6.6 percent in Texas; 4.1 percent in North Carolina; 2.3 percent in Mississippi; and 3 percent distributed in the remaining areas. Most of the filling was for the disposal of dredged material in Louisiana related to oil and gas exploration.

The NMFS recommended against filling on 77 percent of the acreage proposed as follows: Louisiana (80.9 percent); Texas (9.1 percent); Florida (5.5 percent); Alabama (1.4 percent); and the remaining areas (3.1 percent). Vegetated wetlands potentially protected from filling total 8,226 acres (23.3 percent of total for Table 1, column 11), while

Table 3.—Acres of habitat by habitat type involved in NMFS habitat conservation efforts from 1981 through 1985.

	Proposed				Allowed				Conserved				Restore	Generate
	Dredge	Fill	Drain	Impound	Dredge	Fill	Drain	Impound	Dredge	Fill	Drain	Impound		
Black mangrove	74.3	219.2	0.1	30.6	24.7	68.1	0.1	0	49.6	151.1	0	30.6	56.4	98.4
White mangrove	49.0	253.0	0	45.7	14.9	117.2	0	0	34.1	135.8	0	45.7	27.5	100.2
Red mangrove	60.4	395.4	0.1	205.6	3.6	12.7	0.1	0	56.8	382.7	0	205.6	202.1	359.6
Saltgrass	81.2	304.5	0.4	1,394.7	33.6	71.7	0	0	47.6	232.8	0.4	1,394.7	364.1	1,951.1
Freshwater marsh	740.2	2,405.0	380.0	6,831.9	373.3	1,011.9	0	5,734.0	366.9	1,393.1	380.0	1,097.9	30,783.9	2,013.5
Freshwater unvegetated	170.0	66.8	0	0	169.2	68.9	0	0	0.8	- 2.1	0	0	1.5	29.5
Freshwater submerged vegetation	129.6	174.0	12.6	156.4	41.8	90.6	0	0	87.8	83.4	12.6	156.4	102.7	509.4
Hardwood swamp	376.4	1,291.3	887.7	952.0	176.2	381.4	457.0	219.9	200.2	909.9	430.7	732.1	2,557.0	84.1
Black needlerush	212.0	356.0	0.4	1,059.0	21.7	45.9	0	0	190.3	310.1	0.4	1,059.0	98.0	43.1
Other marsh	505.9	2,151.0	309.6	4,513.9	239.2	875.5	0	26.4	266.7	1,275.5	309.6	4,487.5	3,690.4	893.3
Smooth cordgrass	354.9	1,439.7	11.8	3,220.8	105.5	306.7	0	34.1	249.4	1,133.0	11.8	3,186.7	2,344.0	3,883.6
Saltmeadow cordgrass	602.7	2,202.8	4,233.0	7,499.9	279.1	914.9	0	16.5	323.6	1,287.9	4,233.0	7,483.4	36,167.2	1,737.9
Shoalgrass	157.5	34.8	0	0.2	10.0	2.9	0	0	147.5	31.9	0	0.2	15.8	63.8
Halophila	1.5	0.2	0	0	1.5	0.2	0	0	0	0	0	0	0.3	0
Widgeongrass	68.8	148.0	4.1	145.0	40.8	70.6	0	0	28.0	77.4	4.1	145.0	1,031.8	531.7
Manateegrass	8.2	12.0	0	0	3.6	0	0	0	4.6	12.0	0	0	0.8	0.9
Turtlegrass	55.2	28.7	0	1.2	10.9	9.3	0	0	44.3	19.4	0	1.2	1.9	108.7
Eelgrass	1.7	0.2	0	0	1.3	0	0	0	0.4	0.2	0	0	1.4	0.6
Algae	140.8	703.6	0	278.7	20.2	8.0	0	0	120.6	695.6	0	278.7	5.4	4.7
Clay	58.9	3.8	0	0	54.7	0.1	0	0	4.2	3.7	0	0	0	0
Mud	70,808.3	30,979.2	4.3	5,075.7	24,885.1	4,768.4	3.4	504.5	45,923.2	26,210.8	0.9	4,571.2	19,618.5	177.3
Miscellaneous	103.5	360.8	0	19,509.1	53.5	266.9	0	8.3	50.0	93.9	0	19,500.8	13.3	26.4
Oyster beds	13.6	42.3	0	0	0.9	30.0	0	0	12.7	12.3	0	0	0.9	8.6
Rock	155.4	221.7	0	0	3.9	7.9	0	0	151.5	213.8	0	0	0.4	63.9
Sand	4,838.9	1,933.8	1.3	526.6	3,159.3	1,330.5	0	29.8	1,679.6	603.3	1.3	496.8	554.1	74.5
Shell	23.4	77.7	0	0	3.9	2.9	0	0	19.5	74.8	0	0	0.1	1.4
Silt	434.6	87.3	0.1	775.1	406.4	89.0	0.1	775.1	28.2	- 1.7	0	0	0	0
Totals	80,226.9	45,892.8	5,845.5	52,222.1	30,138.8	10,552.2	460.7	7,348.6	50,088.1	35,340.6	5,384.8	44,873.5	97,639.5	12,766.2

27,115 acres (76.7 percent) of unvegetated substrates were potentially conserved.

Draining

Nearly all of the 5,845 acres of wetland draining proposals occurred in Louisiana (87.9 percent) and North Carolina (12 percent). The NMFS objected to draining all but 461 acres of wetlands (7.9 percent). Most of the wetlands involved (5,840 acres) were vegetated. *Spartina patens* (saltmeadow cordgrass) comprised 78.6 percent of the wetlands potentially protected from draining. Hardwood swamps comprised 99.2 percent of the wetlands NMFS did not object to be drained. Most of the wetlands were to be drained for agricultural activities, flood control, and mosquito abatement.

Impounding

Regionwide, 52,222 acres were proposed for impounding (Table 1, column 5). Except for the U.S. Virgin Islands,

impoundments were proposed in every state and ranged from about 2 acres in Alabama to 37,564 acres in Louisiana (73.8 percent). The NMFS recommended against the impounding of 44,873 acres (85.9 percent of the amount proposed). Of the wetlands proposed for impounding (Table 3), 45,845 acres were vegetated (87.7 percent) and 39,806 acres of potential habitat conserved (88.7 percent) were vegetated. Impounding resulted mainly for flood or water control, agriculture, waterfowl hunting, and mosquito abatement.

Mitigation

To offset the losses of habitat that NMFS accepted or did not object to for activities associated with water-dependent projects which require immediate water use or access to achieve their purpose (Table 1, columns 6, 7, 8, and 9) or from unauthorized construction in wetlands, the NMFS recommends the restoration of disturbed wetland habitats

or the generation of new wetlands. Since we do not know if mitigated habitats support the production of fishery organisms to the extent of their natural counterparts, our recommendations for mitigation are made cautiously. From 1981 through 1985, 97,640 acres were recommended for restoration (Table 1, column 14) and 12,766 acres were recommended for generation (Table 1, column 15). Vegetated wetlands comprised 77,451 acres (79.3 percent) of wetlands recommended for restoration and 12,384 acres (97.2 percent) of habitat recommended for generation. Most of the habitat proposed for restoration was in Louisiana (94.7 percent of Table 1, column 14). Most of the generation of new habitat recommended also was in Louisiana (85.5 percent of Table 1, column 15), followed by Florida (6 percent), and Texas (4.4 percent). Using an earlier version of the quantification program, Thayer et al. (In press) estimated that about 4,200 acres of salt marsh (*S.*

Table 4.—Acres of habitat permitted for alteration by the Corps of Engineers from 1981 through 1985.

State	N ¹	Acreage proposed by applicants				Acreage NMFS accepted or did not object to				Acreage COE permitted				Acreage NMFS recommended		Acreage COE permitted	
		Dredge	Fill	Drain	Impound	Dredge	Fill	Drain	Impound	Dredge	Fill	Drain	Impound	Restore	Generate	Restore	Generate
LA	120	1,350.3	1,622.9	201.0	6,378.1	1,182.6	1,075.0	0	5,282.0	1,272.5	1,194.5	0	5,445.8	46,305.3	7,381.8	46,102.9	7,352.8
TX	144	812.3	1,669.5	0	4,791.2	435.9	189.1	0	0	529.5	704.8	0	660.3	2,579.9	450.7	2,578.6	475.0
MS	21	37.2	41.1	0	0	4.3	3.9	0	0	19.7	15.4	0	0	1.1	2.2	0.1	35.5
AL	38	34.8	51.1	0	0.2	18.0	6.7	0	0	17.3	15.5	0	0	5.3	6.4	4.6	6.2
FL	264	719.9	1,165.7	0	100.5	333.7	365.1	0	0	550.3	870.3	0	18.7	64.6	267.1	14.8	88.8
GA	26	274.8	79.3	0	69.0	7.2	5.3	0	0	4.9	26.4	0	27.0	28.1	15.9	7.0	8.7
SC	121	79.1	165.6	0	2,134.1	52.9	35.4	0	0	56.6	46.7	0	6.5	13.8	7.1	13.3	11.3
NC	119	67.3	65.2	0	80.6	18.4	21.6	0	20.4	32.8	25.6	0	20.4	4.8	53.9	4.8	53.6
PR	3	51.2	10.7	0	0	1.2	0.7	0	0	51.2	0.7	0	0	0	0.1	0	0
VI	1	0	1.0	0	0	0	1.0	0	0	0	1.0	0	0	0	1.5	0	0
Total	857	3,426.9	4,872.1	201.0	13,553.7	2,054.2	1,703.8	0	5,302.4	2,534.8	2,900.9	0	6,178.7	49,002.9	8,186.7	48,726.1	8,031.9
Grand total			22,053.7				9,060.4				11,614.4			57,189.6		56,758.0	

¹Refers to number of permits sampled.

alterniflora), hardwood swamp, mangrove, and seagrass were recommended to be transplanted in habitat generation projects between June 1981 and September 1984. The analytical process has been refined since that effort, and our present data more accurately reflect actual permit values.

Cumulative Totals

Collectively, 184,187 acres of habitat were proposed for alteration (Table 1, columns 2+3+4+5) throughout the Southeast Region. Over 81 percent occurred in Louisiana. The NMFS did not object to the alteration of 48,500 acres of habitat (Table 1, columns 6+7+8+9) or about 26 percent of the total proposed and, thus, 135,687 acres would be maintained (Table 1, columns 10+11+12+13). To offset permitted or unauthorized habitat losses, 110,406 acres of habitat were recommended for restoration and generation (Table 1, columns 14+15). This acreage is more than twice the area of wetland alterations that NMFS accepted or to which they did not object.

Effect of NMFS Recommendations

The magnitude and impact of these programs on remaining wetlands in the southeast are obvious by tracking the amount of habitat involved in COE programs for an extended period. If all of the NMFS recommendations were accepted by the COE, considerable wetlands of immense importance to com-

mercial and recreational fisheries could be conserved. Therefore, to test the responsiveness of the COE to NMFS recommendations, 857 permit applications were tracked through permit issuance (Table 4). Of the 22,054 acres of habitat proposed for alteration in this survey, the NMFS accepted or did not object to 9,060 acres (41 percent of the acres proposed for alteration). If NMFS recommendations were followed, 12,994 acres of wetland alterations would have been prevented. The COE permitted the alteration of 11,614 acres of wetlands or 2,554 acres more than NMFS recommended to be conserved. The COE approved 56,758 acres of mitigation, 432 acres less than the 57,190 acres recommended by NMFS.

Responsiveness to NMFS recommendations varied by COE district (Table 5). The "NMFS recommendations accepted" column in Table 5 reflects the number of permit applications where all of the NMFS recommendations were incorporated as permit conditions, or if so recommended, the permit was not issued. Partial acceptance was assigned where only part of the NMFS recommendations were included as permit conditions. The "NMFS recommendations partially accepted" column and the "NMFS recommendations rejected" column result in the 2,554 acres of habitat alterations that were permitted by the COE over NMFS objections. Percentage of NMFS recommendations accepted was highest in the Savannah

Table 5.—Treatment of NMFS recommendations on permit applications by the Corps of Engineers (COE) from 1981 through 1985, by district. Values in parentheses represent percent of N¹ for each category.

COE district	N	NMFS recommendations		
		Accepted	Partially accepted	Rejected
New Orleans	120	47 (39.2%)	70 (58.3%)	3 (2.5%)
Galveston	144	80 (55.5%)	45 (31.3%)	19 (13.2%)
Mobile	59	28 (47.5%)	17 (28.8%)	14 (23.7%)
Jacksonville	268	54 (20.1%)	56 (20.9%)	158 (59.0%)
Savannah	26	23 (88.5%)	0 (0.0%)	3 (11.5%)
Charleston	121	97 (80.2%)	8 (6.6%)	16 (13.2%)
Wilmington	119	103 (86.5%)	9 (7.6%)	7 (5.9%)
Total	857	432 (50.4%)	205 (23.9%)	220 (25.7%)

¹Refers to the number of permits sampled.

District COE (88.5 percent) followed by the Wilmington District (86.5 percent), the Charleston District (80.2 percent), the Galveston District (55.5 percent), the Mobile District (47.5 percent), and the Jacksonville District (20.1 percent). Percentage of partial acceptance was highest in the New Orleans District (58.3 percent) followed by the Galveston District (31.3 percent), the Mobile District (28.8 percent), the Jacksonville District (20.9 percent), the Wilmington District (7.6 percent), the Charleston District (6.6 percent), and the Savannah District (0 percent). Rejection of NMFS recommendations was the highest by the Jacksonville District (59 percent) followed by the Mobile District (23.7 percent), the Galveston and Charleston Districts (13.2 percent each), the Savan-

Table 6.—Survey of permits issued by Corps of Engineers (COE) Districts to determine compliance by applicants with permit stipulations, 1981-85.

COE district	Issued permits monitored	Project status		Applicant complied with permit conditions		Percent compliance
		Completed or underway	Not begun	Yes	No	
Galveston	74	44	30	37	7	84.0
New Orleans	118	79	39	68	11	86.1
Mobile	86	69	17	39	30	56.5
Jacksonville	125	107	18	84	23	78.5
Savannah	30	22	8	16	6	72.7
Charleston	62	39	23	35	4	89.7
Wilmington	89	65	24	59	6	90.8
Total	584	425	159	338	87	$\bar{X} = 79.5$

nah District (11.5 percent), the Wilmington District (5.9 percent), and the New Orleans District (2.5 percent). Region-wide acceptance, partial acceptance, and rejection of NMFS recommendations were 50.4 percent, 23.9 percent, and 25.7 percent, respectively.

Over a 5-year period 584 issued permits were followed to determine applicants compliance with permit conditions (Table 6). Overall, applicants complied with permit stipulations 79.5 percent of the time. Applicant compliance was highest in the Wilmington District (90.8 percent) followed by the Charleston District (89.7 percent), the New Orleans District (86.1 percent), the Galveston District (84 percent), the Jacksonville District (78.5 percent), the Savannah District (72.7 percent), and the Mobile District (56.5 percent). Lindall and Thayer (1982) showed that for FY 1981 compliance with permit conditions was least in the Mobile District and greatest in the Charleston and Savannah Districts.

These data demonstrate the large amount of wetlands involved in COE programs in the Southeast Region. More importantly, the validity of the strong NMFS stand in objecting to unnecessary wetland losses is supported by the potential conservation of at least 135,687 acres of wetlands and the restoration and generation of at least 110,406 acres of additional habitat. Still, these figures are very conservative since the full impact of NMFS involvement in

habitat conservation programs cannot be fully quantified. For example, NMFS biologists conduct a large number of preapplication meetings whereby projects are subsequently modified to reduce their impact on wetlands before the application reaches the COE. Many of these projects result in minimal impact on fisheries. Also, NMFS involvement with the COE interagency planning process, in planning for large federal projects, and in other federal, state, and local planning exercises results in benefits to fishery resources. An example of the latter are the more than 260,000 acres of wetlands under management in Louisiana (estimated from permit applications) for which NMFS involvement has resulted in benefits to fishery resources (P. Keney and J. Lyon, NMFS, Galveston, Tex., personal commun.). Moreover, many of the habitat losses tracked may be small in area yet adversely impact larger wetland systems. Examples include fill deposits which alter circulation patterns within estuaries, and barriers which block access to marine fishery resources and alter freshwater inflow needed to maintain optimum salinity gradients and supply nutrients. The strong NMFS opposition to unnecessary wetland losses has been recognized by consultants, large development firms, oil and gas companies, private citizens, and others. This policy undoubtedly results in permit applications that are modified because it is understood that conserva-

tion agencies will oppose them or in some cases projects will not even be considered because it is believed that a permit will not likely be granted. The effects of conservation programs by the states, the FWS, and the EPA also are not included in our analysis, but would add considerably to the wetlands affected by regulatory programs. Lastly, we tracked only those projects where we could accurately determine areas of wetlands; therefore, not all acreages involved in COE regulatory programs have been quantified.

Conclusions

NMFS has been only partially effective in getting its conservation recommendations included in approved water-development projects and in achieving compliance. However, the amount of habitat potentially conserved (Table 1) and permitted (Table 4) demonstrates the importance of NOAA/NMFS involvement. Additional emphasis by some COE districts is needed in giving NMFS recommendations more consideration in their public interest determinations and investigating compliance by applicants.

Using one commonly cited estimate of the annual value of an estuary to commercial and recreational fisheries of \$100/acre, which is equal to a value of \$2,000/acre capitalized at 5 percent (Gosselink et al., 1974, cited in Lindall and Thayer, 1982), habitat conserved by NMFS recommendations could be worth about \$271.4 million (135,687 acres \times \$2,000/acre). Add to this the value of the habitat potentially restored and generated (110,406 acres \times \$2,000/acre = \$220.8 million), the worth at even these conservative values for the 5-year period would be \$492.2 million to the commercial and recreational fisheries of the Southeast Region. We recognize the value of an acre of wetlands that we use is open to question and that our acreages of wetlands conserved, restored, and generated are composed of a mixture of wetland types. A range of values per acre could be used. For example, Gosselink et al. (1974) calculated the income capitalized value of an acre of tidal marsh (at only a 5 percent interest rate) to be \$82,000/acre

annually for total life support value. This included values related not only to production of commercial and recreational fisheries, but also aquaculture potential and waste treatment. The 5-year worth of wetlands potentially conserved and mitigated by NMFS, using the Gosselink et al. (1974) total life support value, would be increased to almost \$20.2 billion. The benefits derived are accrued year after year for the life of the wetlands without human input. Moreover, the value of wetlands increases as the amount remaining decreases and our knowledge of their functions and associated benefits increases. The overall dollar amount is arguable, but illustrates the potential value of our recommendations. When considered with other unquantifiable benefits of the program (see "Impact of NMFS Recommendations" section), the necessary and vital role by NMFS in conserving and managing the habitat needed by commercial and recreational fishery resources is demonstrated.

The cumulative acreage associated with numerous projects is considerable, but yearly amounts of proposed habitat losses are not consistent between years (Table 2). Therefore, such data need to be collected for a long time so a more accurate picture of effects of small water-development projects relative to remaining wetlands can be obtained.

A major emphasis of NMFS recommendations is to provide for restoration or generation of wetlands associated with water-development activities (110,406 acres for 1981-85). The validity of this concept requires in-depth testing. SEFC research here is vital so appropriate recommendations can be made. For example, NMFS may have to become more conservative in recommending mitigation or making adjustments to the type and quantity of habitat recommended for replacement of lost habitat. Research also is needed to

determine the quantitative relationship between habitat and fishery resources so that effects of habitat alteration on fish and shellfish production can be predicted. This would enable NMFS biologists to develop their recommendations more specifically to the more than 300 estuarine systems in the Southeast Region. Moreover, recommendations would be more effective and defensible when presented for consideration in COE public interest determinations.

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